

## OPERATING EXPERIENCE RELATED TO POWER UPRATES

### Flow-Induced Vibration Issues

The commercial nuclear industry has experienced several incidents of steam dryer cracking and FIV issues at nuclear power plants operating at EPU conditions. The NRC staff continues to closely monitor plant-specific actions and the industry's generic response to this issue. Based on its review, the staff will consider the need for additional regulatory actions.

In June 2002 and again in June 2003, Quad Cities Unit 2 experienced failures of its steam dryer during 17 percent EPU operation. Similarly, the steam dryer in Quad Cities Unit 1 failed during 17 percent EPU operation in November 2003. During a March 2004 refueling outage, Exelon discovered additional cracks in the steam dryer in Quad Cities Unit 2. Exelon identified less significant cracks in the steam dryers in Dresden Units 2 and 3 during their outage inspections. Exelon repaired the damaged steam dryers at Quad Cities and Dresden to improve their structural capability following each instance of steam dryer degradation. In addition to steam dryer cracking, FIV contributed to failures of feedwater sampling probes at Dresden Units 2 and 3, the inoperability of an electromatic relief valve, and degradation of other main steam components and pipe supports at Quad Cities Unit 1.

In response to the adverse flow effects at Quad Cities Units 1 and 2 and subsequent analyses, Exelon committed to maintain those units at pre-EPU power levels, except for limited EPU testing, until the NRC staff is satisfied that the FIV issue is resolved. During the Quad Cities Unit 1 refueling outage in March 2005, Exelon identified cracks in its steam dryer similar to those found in other BWRs operating at uprated power conditions (as well as non-uprated power conditions). The licensee evaluated the structural capability of the modified steam dryers in Dresden Units 2 and 3, and has returned those units to EPU operation. The staff does not consider the FIV issue to pose safety concerns. However, steam dryers and other internal main steam and feedwater components must maintain structural integrity to avoid generating loose parts.

Exelon is planning to install new steam dryers with an improved design in Quad Cities Units 1 and 2 in 2005. The enhanced features of the new steam dryers include thicker outer hoods and cover plates, curved edges to reduce FIV, and slanted outer hood plates. In addition, the new steam dryer in Quad Cities Unit 2 will be instrumented to obtain direct data about the FIV loads acting on the dryer during EPU operation. Over the past 6 months, the staff has conducted numerous public meetings with Exelon to discuss the licensee's FIV analyses for the Dresden and Quad Cities steam dryers and other components, and its extent of condition review of EPU FIV issues. The staff also observed the fabrication of the Quad Cities replacement steam dryers, and installation of the instrumentation on the Quad Cities Unit 2 replacement steam dryer. The staff is currently reviewing the licensee's design and analysis of the replacement steam dryers for Quad Cities Units 1 and 2 to demonstrate its structural capability for EPU conditions, and the startup test procedure for Quad Cities Unit 2 following the steam dryer replacement. The staff expects Exelon to request NRC approval to return Quad Cities Units 1 and 2 to EPU power following replacement of their steam dryers. Entergy has modified the steam dryer at Vermont Yankee to increase its structural

capability in support of its request to operate the plant at EPU conditions. The licensee recently submitted an analysis of the structural capability of the modified steam dryer at Vermont Yankee. The staff is currently reviewing the licensee's analysis.

The staff monitors the inspection results of steam dryers in BWR plants during refueling outages for potential adverse flow effects. For example, licensee inspections of the slanted hood steam dryer at LaSalle Unit 2 in the spring of 2005 found only indications on the lug support bracket only after several years of operation at 5 percent power uprate conditions. Further, licensee inspections of the slanted hood steam dryer at Brunswick Units 1 and 2 in the spring of 2005 following several years of EPU operation found several fatigue and stress corrosion cracks that the licensee has resolved by repair or analysis.

The BWROG is leading the industry's efforts in assessing the generic implications of potential adverse flow effects of power uprate operation, and has several initiatives underway to address this issue. The BWROG issued a lessons learned report in November 2004 to help licensees avoid adverse flow effects of EPU operation. General Electric also revised its steam dryer inspection guidelines in November 2004 in response to industry experience with adverse flow effects under EPU conditions. The staff has provided comments to the BWROG on its EPU lessons learned report and the revised General Electric steam dryer inspection guidelines. The staff will continue to hold public meetings with the BWROG to discuss industry activities to resolve this issue.

The Office of Nuclear Reactor Regulation (NRR) is working with the Office of Nuclear Regulatory Research (RES) on the long-term resolution of potential adverse flow effects of power uprate operation. RES has assisted NRR during reviews of steam dryer analyses presented by licensees at public meetings. NRR is assisting RES in compiling an operating experience report on adverse flow effects of EPU operation at BWR plants. The BWROG has several initiatives to assess industry-wide operating experience with post-EPU FIV issues. NRR is also working with RES in assessing the industry's resolution of the issues.

#### Abnormalities in Ultrasonic Flow Meter Instrumentation

The staff is following the industry's evaluations of a problem at plants that use an ultrasonic flow meter of the type used for MUR power uprates. This problem has led to unexpected but small differences in power level indications at some plants. The staff is closely monitoring this issue to identify information relevant to the use of feedwater measurement techniques in power uprate applications. The staff is also clarifying the safety evaluation basis for feedwater measurement techniques in power uprate applications, based on the operating experience. After completing the evaluation of pending MUR power uprate applications, the staff will determine whether a generic communication or updating staff review guidance is needed.